# STIRLING COOLER

## BACKGROUND OF THE INVENTION

### Field of the Invention

The present invention relates to a stirling cooler, and more particularly to a stirling cooler, in which a packing for maintaining a hermetically sealed state is positioned at a portion connecting a cylinder and a case in an axial direction of the cylinder.

### Description of the Related Art

As shown in Fig. 1, a conventional stirling cooler comprises a case 4 provided with a cold tip 2 at an opened end thereof, a cylinder 6 fixedly installed in the case 4 and filled with a fluid, a piston 8 installed in the cylinder 6 such that the piston 8 can reciprocate, and provided with a hollow 7 formed therein, a displacer 10 installed in the hollow 7 of the piston 8 such that the displacer 10 can reciprocate, a regenerator 12 longitudinally connected to the displacer 10, and provided with a cavity 1 positioned between the regenerator 12 and the cold tip 2 and filled with the fluid, and a heat exchanger 14 connected to the cylinder 6 and the regenerator 12.

A flange 5 is vertically formed along an outer surface

of the cylinder 6 in a radial direction, and a protrusion 3, on which the flange 5 is seated in an axial direction of the cylinder 6, is formed on the case 4. The flange 5 of the cylinder 6 is connected to the protrusion 3 of the case 4 by screws 16.

The piston 8 is connected to a linear motor 18 installed between the case 4 and the cylinder 6, and reciprocates. The displacer 10 is connected to an elastic member 19 installed in the case 2 such that the displacer 10 is opposite to the regenerator 12, thus being elastically supported such that the displacer 10 faces the cold tip 2. A hole 11 is formed in a lower part of the regenerator 12 being opposite to the cold tip 2.

The heat exchanger 14 includes an inner heat exchanger 13 installed in a heat exchange chamber 20 prepared between the cylinder 6 and the case 4, and an outer heat exchanger 15 installed on an outer surface of the case 4 so that the case 4 is interposed between the inner heat exchanger 13 and the outer heat exchanger 15. A first hole 22 communicating with the heat exchanger chamber 20 is formed through the cylinder 6, and a second hole 24 communicating with a hole 9 formed through the displacer 10 positioned at the heat exchange chamber 20 and the regenerator 12.

An O-ring 30 is positioned at a contact portion of the outer surface of the cylinder 6 and the case 4 in a radial

direction of the cylinder 6 so that the fluid does not leak from the heat exchange chamber 20.

Hereinafter, operation of the above-described conventional stirling cooler will be described in detail.

When the piston 8 moves close to the cold tip 2, the fluid of the cylinder 6 is isothermally compressed, and is discharged to the heat exchange chamber 20 to emit heat. Then, the fluid is introduced into the regenerator 12 to emit sensible heat, and fills the cavity 1 between the regenerator 12 and the cold tip 2 and is isothermally expanded simultaneously. Here, as the fluid fills the cavity 1 between the regenerator 12 and the cold tip 2, the regenerator 12 and the displacer 10 move away from the cold tip 2.

Thereafter, when the piston 8 moves away from the cold tip 2, the displacer 10 and the regenerator 12 are returned to their earlier positions toward the cold tip 2 by the elastic force of the elastic member 18. The fluid filling the cavity 1 between the regenerator 12 and the cold tip 2 subsequently passes through the regenerator 12 and the heat exchange chamber 20 to absorb heat, and re-fills the cylinder 6.

Since the cylinder 6 provided with the O-ring 30 is inserted into the case 4 in the conventional stirling cooler, the O-ring 30 between the case 4 and the cylinder 6 is overloaded, thus being damaged and causing change in an axis of the cylinder 6. Thereby, the displacer 10 and the piston 8

reciprocating in the cylinder 6 are easily worn out, thus causing errors in operating the stirling cooler.

## SUMMARY OF THE INVENTION

Therefore, the present invention has been made in view of the above problems, and it is an object of the present invention to provide a stirling cooler, in which a packing prevents a fluid from leaking and does not influence an axis of a cylinder when the cylinder is assembled in a case.

In accordance with one aspect of the present invention, the above and other objects can be accomplished by the provision of a stirling cooler comprising: a case provided with a cold tip at an end thereof; a cylinder fixedly installed in the case and provided with a piston reciprocating therein; a displacer installed in the piston such that the displacer can reciprocate; a regenerator positioned between the displacer and the cold tip; a heat exchanger connected to the regenerator and the cylinder; and a packing positioned at an area, in which the cylinder contacts the case, in an axial direction of the cylinder.

Preferably, the heat exchanger may include an inner heat exchanger installed in a heat exchange chamber positioned between the cylinder and the case, and an outer heat exchanger installed on an outer surface of the case opposite to the

inner heat exchanger; and the packing may be positioned at the heat exchange chamber for maintaining the sealed state of the heat exchanger chamber.

Further, preferably, an O-ring may be installed at an outer surface of the cylinder opposite to the inner heat exchanger.

Moreover, preferably, an O-ring may be installed at a portion of the cylinder contacting the case in a radial direction of the cylinder for defining the heat exchange chamber, and the O-ring and the packing may be respectively positioned at opposite sides of the heat exchange chamber in the axial direction of the cylinder.

Preferably, the packing may be interposed between a flange protruded perpendicularly from an outer surface of the cylinder and a stair of the case on which the flange is seated.

Further, preferably, through holes for connecting the flange of the cylinder and the stair of the case by screws may be formed through the packing.

Moreover, preferably, the packing may have a ring shape so that it is inserted into the outer surface of the cylinder.

In accordance with another aspect of the present invention, there is provided a stirling cooler comprising: a case provided with a cold tip at an end thereof; a cylinder

fixedly installed in the case and provided with a piston reciprocating therein; a displacer installed in the piston such that the displacer can reciprocate; a regenerator positioned between the displacer and the cold tip; a heat exchanger including inner and outer units respectively installed at the inside and outside of a heat exchange chamber positioned between the cylinder and the case and connected to the regenerator and the cylinder; and a packing interposed between a flange protruded perpendicularly from an outer surface of the cylinder and a stair of the case on which the flange is seated in an axial direction of the cylinder for maintaining the sealed state of the heat exchange chamber.

In accordance with yet another aspect of the present invention, there is provided a stirling cooler comprising: a case provided with a cold tip at an end thereof; a cylinder fixedly installed in the case and provided with a piston reciprocating therein; a displacer installed in the piston such that the displacer can reciprocate; a regenerator positioned between the displacer and the cold tip; a heat exchanger including inner and outer units respectively installed at the inside and outside of a heat exchange chamber positioned between the cylinder and the case and connected to the regenerator and the cylinder; a packing interposed between a flange protruded perpendicularly from an outer surface of the cylinder and a stair of the case on which the flange is

seated in an axial direction of the cylinder for maintaining the sealed state of the heat exchange chamber; and an O-ring positioned at an outer circumference of a portion of the cylinder defining the heat exchange chamber such that the O-ring is separated from the packing in an axial direction of the cylinder and contacts the case in a radial direction of the cylinder.

## BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a longitudinal-sectional view of a conventional stirling cooler;

Fig. 2 is a longitudinal-sectional view of a stirling cooler in accordance with the present invention; and

Fig. 3 is a plan view of a packing of the stirling cooler in accordance with the present invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now, a preferred embodiment of the present invention will be described in detail with reference to the annexed drawings.

The present invention may comprise several embodiments, but the most preferred embodiment will be described hereinafter. In the following description of the present invention, a detailed description of known functions and configurations incorporated herein will be omitted when it may make the subject matter of the present invention rather unclear.

As shown in Fig. 2, a stirling cooler in accordance with the present invention comprises a case 50 provided with a cold tip 52 at an opened end thereof, a cylinder 54 fixedly installed in the case 50 and filled with a fluid, and a packing 70 positioned at a contact area between the case 50 and the cylinder 54 in an axial direction of the cylinder 54.

A linear motor 56 is installed between the case 50 and an upper part of the cylinder 54, a piston 58 connected to the linear motor 56 is installed in the cylinder 54 such that the piston 58 can reciprocate, a displacer 62 supported by an elastic member 60 installed on the case 50 is installed in the piston 58 such that the displacer 62 can reciprocate, and a regenerator 64 is installed between the displacer 62 and the cold tip 52.

A heat exchange chamber 66 is installed in the case 50 and the lower part of the cylinder 52, and communicates with the cylinder 52 and the regenerator 64 such that the heat exchange chamber 66 exchanges heat of the fluid with the

cylinder 52 and the regenerator 64. An inner heat exchanger 68 is installed in the heat exchange chamber 66, and an outer heat exchanger 69 surrounding the heat exchange chamber 66 is installed on an outer surface of the case 50 so that the case 50 is interposed between the inner heat exchanger 68 and the outer heat exchanger 69.

Here, the heat exchange chamber 66 is configured such that two contact portions 53 and 53' of the cylinder 54, which are separated from each other in the axial direction of the cylinder 54, contact the case 50, and the lower contact portion 53' of the cylinder 54 has a width narrower than that of the upper contact portion 53 of the cylinder 54. Further, the case 50 has a stepwise structure including two stairs 51 and 51' so that the upper stair 51 of the case 50 contacts the upper contact portion 53 of the cylinder 54 and the lower stair 51' of the case 50 contacts the lower contact portion 53' of the cylinder 54, thereby being provided with the heat exchange chamber 66.

The fluid flows in the heat exchange chamber 66 between the cylinder 54 and the regenerator 64, and requires the packing 70 for maintaining a hermetically sealed state of the heat exchange chamber 66, inserting the cylinder 54 into a gap between the stairs 51 and 51' of the case 50 and preventing the change in an axis of the cylinder 54.

Since the upper stair 51 of the case 50 more influences

the axis of the cylinder 54, the packing 70 is positioned at the upper stair 51 of the case 50.

Accordingly, a flange 55 is protruded perpendicularly from the outer surface of the cylinder 54 in a radial direction, and seated on the upper stair 51 of the case 50 in the axial direction of the cylinder 54, and the packing 70 is interposed between the upper stair 51 of the case 50 and the flange 55 of the cylinder 54.

The above packing 70 has a ring shape so that it is inserted into the whole outer circumference of the cylinder 54 for hermetically sealing the heat exchange chamber 66. Further, a radius of the packing 70, i.e., a distance from a center of the packing 70 to the outer circumference of the packing 70, is approximately the same as a distance from the center of the cylinder 54 to the flange 55 of the cylinder 54 in the radial direction of the cylinder 54. Here, in order to uniformly compress the ring-shaped packing 70 in the radial direction of the cylinder 54 and firmly sealing the heat exchange chamber 66, the flange 55 of the cylinder 54 has a ring shape. Therefore, the packing 70 and the flange 55 of the cylinder 54 have the same shape.

Since the upper stair 51 of the case 50 and the flange 55 of the cylinder 54 are connected to each other by screws 80, the packing 70 includes through holes 71, into which the screws 80 are inserted, so that the packing 70 together with

the cylinder 54 is fixed to the case 50.

An O-ring 72 for firmly maintaining the sealed state of the heat exchange chamber 66 is positioned at the lower contact portion 53' of the cylinder 54. The O-ring 72 and the packing 70 are opposite to the heat exchange chamber 66 in the axial direction of the cylinder 54, thus maintaining the sealed state of the heat exchange chamber 66.

Further, an O-ring 74 for maintaining the sealed state of the inner heat exchanger 68 is positioned at the outer surface of the cylinder 54 located at the height of the heat exchange chamber 66.

Hereinafter, operation and effects of the cryogenic regenerator in accordance with the present invention will be described in detail.

When the linear motor 56 is operated, the piston 58 moves close to the cold tip 52 and the fluid of the cylinder 54 passes through the heat exchange chamber 66 and the regenerator 64 and flows between the regenerator 64 and the cold tip 52. Then, the regenerator 64 and the displacer 62 move away from the cold tip 52.

On the other hand, when the piston 58 moves away from the cold tip 52 by means of the operation of the linear motor 56, the fluid filling a gap between the regenerator 64 and the cold tip 52 flows into the regenerator 64 and the heat exchange chamber 66 and re-fills the cylinder 54.

Here, since the heat exchange chamber 66 is firmly sealed by the packing 70 and the O-rings 72 and 74, the fluid filling the heat exchange chamber 66 cannot leak into spaces other than the regenerator 64.

Since the packing 70 between the upper stair 51 of the case 50 and the flange 55 of the cylinder 54 is compressed in the axial direction of the cylinder 54, the cylinder 54 is easily assembled in the case 50. Further, the piston 58 and the displacer 62 reciprocate in the axial direction of the cylinder 54, thus improving the life span of the cylinder 54, the piston 58 and the displacer 62.

Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.